

Language Models can Solve Computer Tasks

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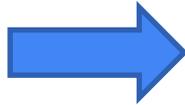
²Carnegie Mellon University



Intro



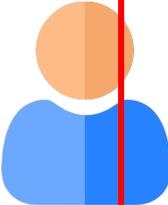
Control &
Decision making



A collage of various digital interfaces. At the top left is a spreadsheet titled "Financial Projections" with columns for months and values. Below it is a dashboard for "Good Morning, Logan McNeil" with sections for "Awaiting Your Action", "Quick Tasks", and "Announcements". To the right is a United Airlines flight booking interface showing a roundtrip from Tampa, FL to New York/Newark, NJ. Below the flight interface is a Google search page with the Google logo and a search bar. At the bottom right is an Amazon e-commerce page featuring "Explore Valentine's Day Shop deals" with various product categories and promotional banners.

Motivation

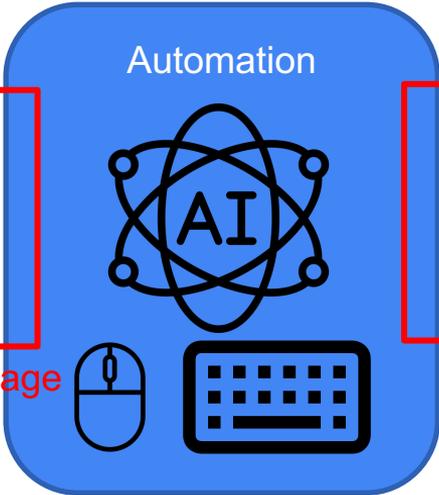
Generalization!



Instruction



1. Natural language instruction



Control & Decision making



2. Tasks

3. Webpage

A screenshot of a webpage, likely a travel booking site, showing flight options and search results. The page includes a search bar, flight details, and a table of flight options. A red box highlights the entire screenshot area.

Previous Approaches

Challenge

Generalization

Approaches

Imitation learning

Reinforcement learning

Limitations

Large amount of expert demonstration data

Task-specific reward functions

Does not scale!

Solution

Solution: **Using LLM**

World knowledge stored in the foundation model

In-context learning for a few-shot approach

But how can LLM be grounded in computer tasks?

No reward function is needed!

Generalization to
(i) instructions (ii) tasks (iii) webpage

Less than 2~3 demonstration per task

Recursively Criticize and Improve (RCI) !

RCI for Reasoning

Can language model improve its output?

Prompts

Outputs



Q: Valerie earns \$5000 per month, 1/2 of what her brother earns. If their mother earns twice their combined salary, what's the total amount of money they all have together?

A:

Valerie's brother earns \$10,000 per month, while Valerie herself earns half of that amount. Together, they earn a total of \$15,000 per month. Their mother's monthly earnings amount to \$30,000, which is twice the combined salary of Valerie and her brother. Thus, the total amount of money they all have together is \$30,000. (Incorrect)



<Critique step>



Review your previous answer and find problems with your answer.

All individuals, including Valerie, her brother, and mother, should be taken into account when calculating the overall sum of money.



<Improve step>



Based on the problems you found, improve your answer.

Valerie's brother earns \$10,000 per month, while Valerie herself earns \$5,000. Together, they earn a total of \$15,000 per month. Their mother earns double their combined salary, which amounts to \$30,000 per month. In total, they have \$45,000 collectively. (Correct)



Evaluation on Reasoning Tasks

	GSM8K	MultiArith	AddSub	SVAMP	SingleEq
Zero-Shot	78.35	96.06	85.83	78.35	91.34
Zero-Shot + RCI	85.43	97.64	89.76	84.65	94.49
Zero-Shot CoT	82.28	96.85	83.86	79.92	89.37
Zero-Shot CoT + RCI	86.22	97.24	89.88	85.83	90.94
Few-Shot CoT	80.31	98.82	89.37	83.46	91.73
Few-Shot CoT + RCI	84.25	99.21	90.55	87.40	93.70

- *Zero-Shot + RCI* outperforms *Zero-Shot CoT* and *Few-Shot CoT*
- No notable improvements in tasks where standard prompts mostly succeed (MultiArith).
- [RCI and CoT have a synergistic effect](#)

RCI for Computer Agent

Use the terminal below to delete a file ending with the extension `.rb`

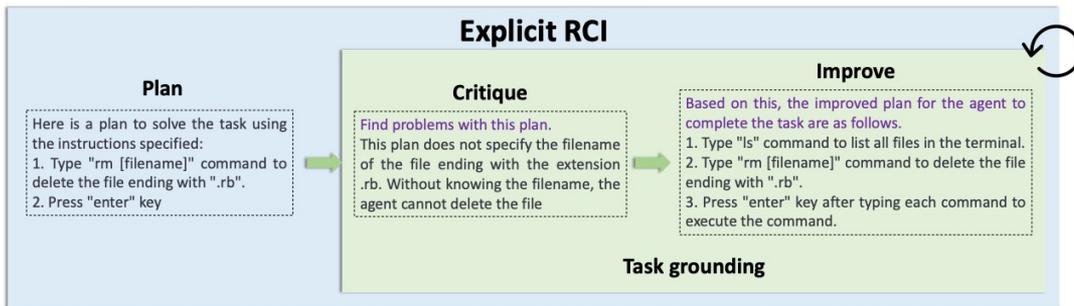
```
terminal
Welcome! Type help for a list
of available commands.
Last login: Mon Jan 30 2023
user$
```

Initial state

```
terminal
Welcome! Type help for a list
of available commands.
Last login: Mon Jan 30 2023
user$ ls
alloy.jpg code.rb file.gpg
navigator.txt skynet.html
thunderbird.html
user$
```

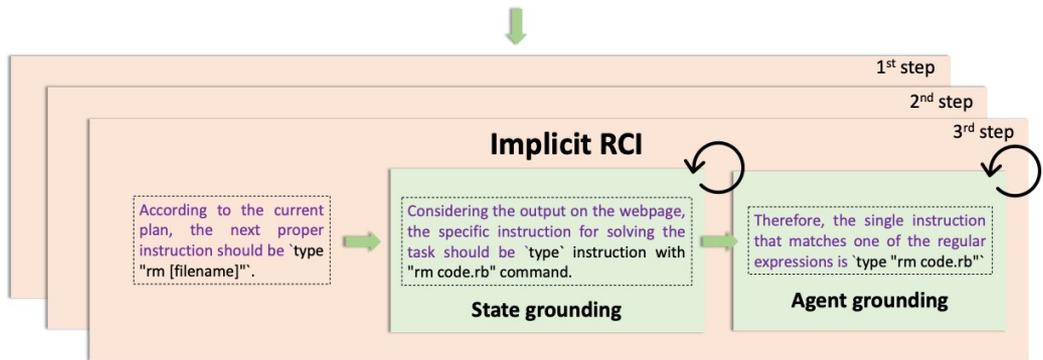
Current state

Task: The task is to use the terminal below to delete a file ending with the extension `.rb`.



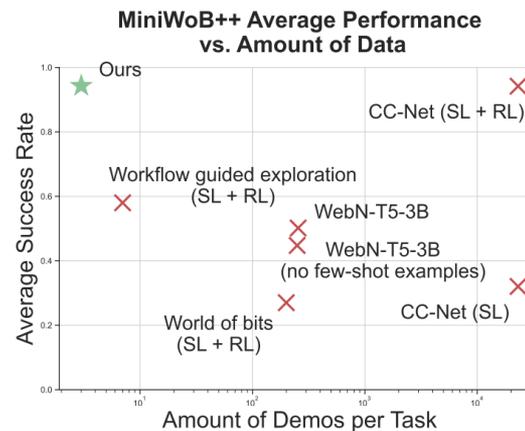
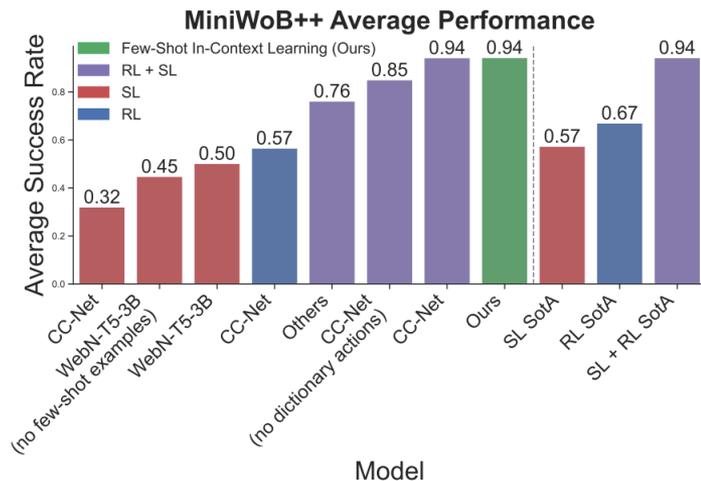
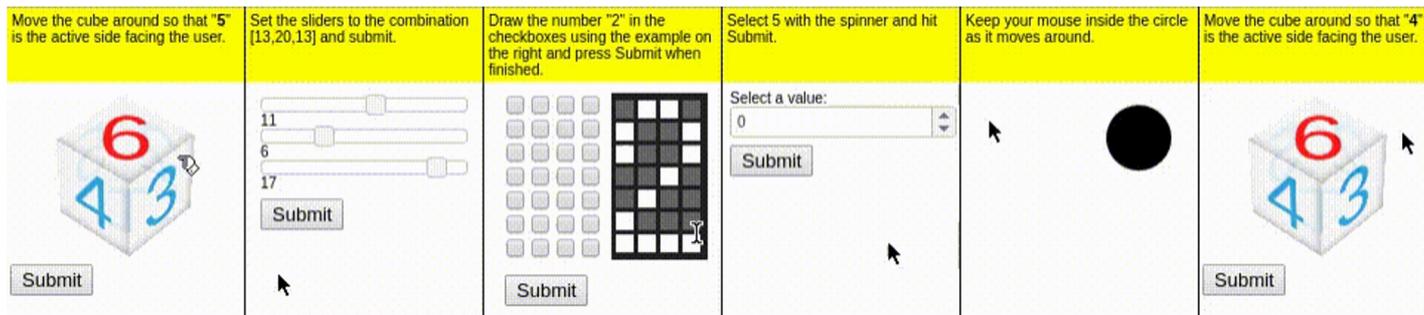
Explicit RCI

Separate Critique step and Improve step



Implicit RCI
Critique and improve at once

Evaluation on MiniWoB++ Tasks



Limitations

Constraints on the underlying LLM – reasoning ability, HTML understanding, context length

RLHF of LLM is crucial

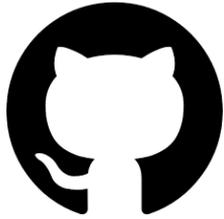
Expensive – multiple sampling is needed to sample a single action

Variations of RCI prompting can be developed

HTML state representation – the agent cannot recognize visual elements in webpages

Multimodal foundation models (e.g., screenshot images)

RCI Agent



GitHub



Website

